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*Eclipidrilidae and their Anatomy.
A new Family of the limicolle Oligochaeta.
Gustaf Eisen.*

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E C L I P I D R I L I D Æ

AND THEIR

ANATOMY.

A NEW FAMILY OF THE LIMICOLIDE OLIGOCHÆTA.


BY

GUSTAF EISEN.

WITH TWO PLATES.

◀PRESENTED TO THE ROYAL SOCIETY OF SCIENCES IN UPSALA, THE 4 MARCH 1881).

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Two years ago, or 1878, while travelling among the snowy peaks of California's Sierra Nevada, my attention was attracted to a small limicolide Oligochæte, which I at first sight easily recognized as new and interesting. I was at the time not armed with any microscope or even stronger lens, and could therefore not even preliminary study its vascular system, and specimens which I attempted to preserve alive until my arrival to the plains, died unfortunately already on the second day after captivity.

The worm was found in a small rapidly flowing spring, which for 9 months of the year must certainly remain icebound and whose waters for the three remaining months never could have attained a temperature of much over 40° Fahr.

The few specimens which I preserved in alcohol proved upon examination to belong to a worm, whose many new and remarkable features placed it in an entirely isolated systematic position among the Oligochæta. To investigate the vascular system of the same I had no other choice than to return the following year to the high Sierra-Crests and, better provided with instruments, work out the circulatory part of the anatomy on the spot. This successfully done the rest of the anatomy was studied from dissections of alcoholic specimens.

In the following I will first shortly characterize the Family and genus and afterwards more minutely present the anatomical characteristics and compare them with those of other nearly related families.

ECLIPIDRILIDÆ. Fam. nov.

Vascular system consists of two primary longitudinal vessels: one ventral vessel not pulsating, and one dorsal vessel pulsating.

Generative system. The *efferent ducts* are not connected with the testes, and their free interior extremities are not furnished with any efferent funnels, but here considerably elongated and enclosing a sack-like *Vesicula seminalis* or male seminal receptacle. The atrium of the efferent duct is furnished with 3 minute openings for the entering of the spermatozoa. The oviducts are two, not directly connected with the efferent duct, nor invaginated by the same.

The spines are entire, occur in pairs of 2, of which 4 in every segment, as in the families of *Tubificidæ* and *Lumbriculidæ*.

ECLIPIDRILUS nov. gen.

The *dorsal vessel* is weakly pulsating not furnished with any hearts and not branching.

The *ventral vessel* is not pulsating but branching in the first setigerous segment of the body.

The *lateral or secondary vessels* are partly gastric, partly perigastric, but both kinds are not found originating in the same segments. The dorsal and ventral vessels are not connected by secondary vessels in the 30 odd last segments of the body.

The two *efferent ducts* are found in the 9th setigerous segment, and extends backwards to the 14th segment or so. An exterior penis present.

The two *oviducts* in the 9th segment and opening between the 9th and 10th setigerous segments.

The *ovaries* in 3 pairs, one each in the 8th, 9th & 10th setigerous segments.

The *testes* are amorphous, one paire in the 10th to 13th setigerous segments.

As yet only a single species is known, viz:

ECLIPIDRILUS FRIGIDUS n. sp.

Vascular system. The dorsal and ventral longitudinal vessels are of nearly the same size, the former only is pulsating. The ventral vessel is forked in the first setigerous segment of the body, the dorsal vessel is entire, connecting with the two forks of the ventral vessel in the cephalic lobe (Pl. I. fig. 2. D. v. & v.v.)

The secondary or lateral vessels are of two kinds viz.:

- a. *perigastric*, situated in the perigastric cavity of the body, and
- b. *gastric*, situated on or close to the alimentary canal.

The *perigastric vessels* are of two kinds, viz.:

1. Connecting perigastric vessels, and
2. free perigastric vessels.

The *connecting perigastric* vessels are found in the anterior segments of the body, connecting the two principal longitudinal vessels. One pair is found in the buccal segment and one pair each in the nine first setigerous segments. (Pl. I. fig. 2. p.v.). The two last *connecting perigastric vessels*, originating respectively in the 8th & 9th setigerous segments, are considerably longer than the rest and furnish blood both to the generative and copulative organs. They are also not confined to their respective segments but extend considerably backwards, sometimes as far as to the 10th or 14th segment. The anterior pair is the shortest, and extends only to the 10th segment, while the pair originating in the 9th segment extends as far back as the 14th segment or as far as the sexual organs reach. In the 10th and following posterior segments, no connecting perigastric vessels are found. None of these connecting perigastric vessels are dilated to hearts, but all are slightly pulsating, the anterior ones more so than the posterior ones (fig. 2).

The *free perigastric vessels* are dorsal and found in the 30 odd posterior segments, two pair in every segment, emitted from the pulsating dorsal vessel, and also themselves slightly pulsating. As to the form, they are short, thick, and all more or less imperfectly forked or branched. Their inner end is free, and does not connect with the ventral vessel, (Pl. I. fig. 3. pv.).

Of the *gastric vessels* one pair is found in every segment, which does not contain any perigastric vessels: The gastric vessels run along side the alimentary canal and connect the ventral and dorsal longitudinal

vessels with each other. Between these gastric vessels we find a perfect net of tertiary rectilinear vessels, running in and on the layers of the alimentary canal. (Pl. I. fig. 2. g. v. p. & g. v. s.).

From the head backwards we therefore meet with the following secondary vessels: In the first segments inclusive the 9th only connecting perigastric vessels, one pair in every segment. From the 10th segment and backwards gastric vessels between which a perfect net of rectilinear secondary gastric vessels. In the 30 odd last segments we find only *free* perigastric vessels, 2 pairs in every segment, none of which is connected with the ventral vessel.

Thus the vascular system of *Eclipidrilus*, however characteristic, does greatly resemble the same system in *Tubificidæ* and *Lumbriculidæ*. The most characterizing feature is the presence of only one pair of secondary vessels in every segment except the 30 last ones. In most genera of the above families we generally find both gastric and perigastric vessels in the same segment. In *Eclipidrilus*, this is never the case.

An other prominent feature is the unusual length of the perigastric vessels in the 8th & 9th segments. A somewhat similar elongation of the perigastric vessels is also found in *Telmatodrilus*¹⁾ in the family of *Tubificidæ*. In this genus however the perigastric vessels are confined to their proper segments, performing however the same duty, viz: the furnishing of blood to the sexual organs.

The forking or imperfect feathering of the posterior perigastric vessels, is also found in *Phreatothrix* Vejd.²⁾. But in this worm, as in all other genera of *Tubificidæ* and *Lumbriculidæ*, the ventral and dorsal vessels are always connected by secondary vessels.

The blood is redish yellow and sufficiently bright to appear through the body wall. Even for the unarmed eye the ventral vessel appears as a red continual streak, from which sometimes even the secondary vessels are seen branching.

The *alimentary canal* is extremely simple. It consists merely of a simple duct, similar to that of *Tubificidæ*. In the 5 first setigerous segments the duct is pellucid, but in the following segments it is covered with dark opaque glands, similar to those so often found in near related families.

The *nervous system* of *Eclipidrilus* presents no very distinct characteristics. The two ventral nerve cords, which together form the ventral

¹⁾ *Bihang.* K. Svenska Vet.Akad. Handl. Bd. 5. N. 16. pag. 8.

²⁾ *Zeitschr. f. W. Zoologie.* Bd. XXVII. pag. 541 etc.

nervetrunc, are as in *Telmatodrilus* connected by numerous anastomosing commissures of the same width, or wider even than the cords themselves. (Pl. II. fig. 8). The cephalic plexus forms a cephalic ganglion in size and form very similar to that of *Rhynchelmis*¹⁾ and *Ocnerodrilus*²⁾. The emargination of its frontal margine is rather slight, but the posterior lobes are plain and projected. The nuclei and nucleoli of the cephalic ganglion are large and distinct and rather closely packed. No lateral or secondary nerves are projected either from the ventral trunc or from the cephalic ganglion.

Generative system. The sexual organs are of two kinds viz: *Generative* and *Receptive*.

The *Generative* organs are either
male, or *testes*, or
female, or *ovaries*.

The *Receptive* organs are also
male, or *efferent ducts*, or
female, or *oviducts* and
receptacles.

The *testes* consist of two large sacklike and amorphous bodies, situated in the segments 9th to 13th incl., one on each side of the body, and entirely covering the other sexual organs in the same segments. (Pl. I. fig. 1. t).

Similar testes are found both in *Tubificidæ* and *Lumbriculidæ*. In the former family in *Spirosperma ferox*³⁾ in the latter in *Rhynchelmis*⁴⁾ and *Phreatothrix*⁵⁾.

The testes contain numerous cysts of spermatozoa, but no free ones. Each such cyst consist of a globular body, attached to, or tapering to a round wedge-shaped tail. This body is covered with smaller globules full of a granulated, oily matter, among which cellnuclei resembling bodies are intermixed. The tail of this spermatozoa-cyst is sometimes straight, sometimes bent, and is always covered by globules, which are either partly separate, or which run together forming beautifully elevated ridges. (Pl. I. fig. 7.). These ridges are either transversal, spiral, or longitudinal, and separated by fields of equal size and regular

¹⁾ Zeitschr. W. Zoologie. Bd. XXVII, pag. 332.

²⁾ Nova Acta Reg. Soc. Sc. Ups. Ser. III. vol. X, N:o 10.

³⁾ Bihang. K. Svenska Vet. Akad. Handl. Bd. 5. N. 16.

⁴⁾ Zeitschr. f. W. Zoologie. Bd. XXVII. p. 332.

⁵⁾ Zeitschr. f. W. Zoologie. Bd. XXVII. p. 541.

form. The regularity and beauty of this structure can only be compared with that of skeletons of certain Diatoms. These spermatozoa-cysts are not unlike the spermatophores of *Tubificidæ*.

The ovaries occur in 3 pairs and are of very diminutive size. (Pl. I. fig. 1.; Pl. II. fig. 11). The anterior pair is found in the 3th segment, attached to the dissipation between this and the 4th segment. The second pair is similarly found in the 9th segment, attached to the dissipation between the same and the 8 segment. The last or 3th pair is found in the 10th segment, attached to the dissipation between the same and the 9th setigerous segment.

The form of the ovary is variable, still the ovaries of the same pair is mostly of the same shape, sometimes resembling a bagpipe, sometimes again more like a complicated S. The matured ova are always situated at the free margin of the ovary, but even they are of such diminutive size, that they even when fully developed are only 2 or 3 times larger than the smallest ovula in the ovary.

As oviducts (Pl. I. fig. 6 & 1) I consider two very minute and extremely delicate organs, of a shape somewhat similar to the oviducts of the genera of *Lumbriculidæ*, and which are situated in the 9th segment. The exterior porus of the oviduct is found between the segments 9 & 10, in a line between the spines and the porus of the efferent duct (Pl. I. fig. 4. ovd.). The oviduct is funnel-shaped with a proportionately large globular and bladderlike interior orifice. This latter is not furnished with vibrating ciliæ, which are wholly restricted to the interior tube of the organ.

The receptacle (Pl. I. fig. 1 & Pl. II. f. 12) consist of two large chitinous bodies, situated in the 8th setigerous segment, and whose external porus opens a little behind the spines of that segment. Each receptacle consists of two distinct parts, the interior of which is inflated and egglike, — the receptacle proper — and one more narrow tubelike part, connecting the former with the exterior porus of the organ.

The *receptacle* shows a great similarity with the same organs of *Tubificidæ* and *Lumbriculidæ*. Its interior cavity is nearly always full of free spermatozoa with long and sharply defined tails.

The *efferent ducts* are 2, of enormous size, occupying the segments 9 to 14. The exterior porus of the duct is situated in the 9th segment just behind the ventral spines. Each efferent duct consists of two large, rather cylindrical, sacklike ducts of nearly equal size, which at the extremities are connected by a narrow, short tube, of the same general structure as the rest of the organ, except being surrounded by spiral muscles (Pl. II. fig. 13 & 14. spr).

The interior extremity of the ducts is free, suspended in the perigastric cavity of the body, but the exterior extremity is, as usual, attached to the body wall, and a part of it projects beyond the same forming a retractile exterior penis proper (fig. 13. p.). The longest of the two bags, which constitute the efferent duct, is the one directly connected with the body wall, and is nearer its interior end furnished with 3 very minute circular openings, through which the spermatozoa evidently enter.

Inside and freely suspended within this exterior duct we find another interior one, of very much the same form and size as the former, only it is somewhat shorter, its exterior extremity being free and not attached to the body wall, nor being able to be projected through the same. This extremity is furnished with a large circular opening. The inner extremity of this interior duct ends blindly, and is always full of spermatozoa and serve accordingly as a true seminal vesicle, in which the spermatozoa are stored, before they are ejected through the sexual porus.

The exterior duct consists of at least three different layers, one exterior epithelial layer, one middle layer, much thicker than the others, consisting of heavy longitudinal muscles, and one interior membranous layer, which at the exterior extremity is separated from the two former ones and form by itself a pellucid membranous penis, at times found projected through the sexual porus. The two exterior ones of these layers connect directly with the body wall of which they seem to be a mere continuation. This structure of the exterior duct is the same throughout the organ, except at the narrow tube, which connects the two sacks (the seminal vesicle and the atrium) which former is surrounded by numerous spiral muscles, very similar to those found in *Camptodrilus* ¹⁾ (fig. 13 & 14 spr.).

If we therefore consider the course a spermatozoon can take, after having escaped from the testes, we find that the efferent duct is most admirably adopted to the purpose of transmitting and storing spermatozoa. A spermatozoon after having entered the efferent duct, through one of the three small circular openings (or. fig. 13 & 14) passes down the exterior duct towards the sexual porus, but is on its way intercepted by the exterior opening of the inner duct (fig. 13 or. in.), and attracted by the ciliated epithelium of its inner surface, ascends through the exterior part of the duct (fig. 13 in) up through the narrow tube and is finally lodged in the seminal vesicle, and is here stored untill of future use.

¹⁾ *Preliminary Report on Tubificidæ.* Bihang till K. Vet.Akad. Handl. Bd. 5. N. 16. fig. 6.

The spiral muscles round the narrow tube, which can easily be contracted serve evidently to keep the spermatozoa in the seminal vesicle and prevent them from escaping in undue time. From the form and free suspension of the inner duct, it may easily be seen that its free exterior extremity can be considerably extended clear down to the penis proper at the moment of copulation.

The end of the penis is generally straight, slightly swelled, but is also found helixlike (fig. 13. p.).

The total absence of efferent funnels is a characteristic of great value, not met with anywhere else in this class of worms, and which places *Eclipidrilus* in a decidedly isolated position. The general structure and arrangement of the generative organs as well as the simplicity of the ventral vessel etc. shows this worm to be a true limicolide oligochaete, and nearest allied to the families of *Tubificidae* and *Lumbriculidae*.

The *segmental* organs are with certainty present in all the segments posterior to the 9th setigerous segment, but in the anterior segments I have not yet discovered them. These organs are extremely delicate and consist of a long slender and simple tube, whose exterior porus is found just in front of the ventral spines and in a straight line drawn between the spines, the efferent duct, the oviduct and seminal receptacle of the same side (fig. 4). The interior end of each segmental organ is as usual projected into or through the dissipation of each anterior segment. The neck of the organ is here considerably swelled, bottle like, and glandulous, and the orifice itself is surrounded by large and small globular and pellucid inflations. (Fig. 9).

The *spines* are absent in the cephalic lobe and buccal segment, but in all the other segments, we find 8 spines in 4 pairs, as in *Lumbriculidae*. The spines are slightly S shaped and their free ends entire.

Habitat. *Eclipidrilus frigidus* is as yet only found in the high *Sierra Nevada* of *California* at an altitude of 10,000 feet or more. It lives here in the bottom mud or more frequently yet among moss attached to rocks over which the cold or even icy water is constantly flowing at least during the warm season. The head end of the worm is generally burrowed in the mud or moss, and the tail freely vibrating in the water.

Explanation of the figures.

Pl. I.

Eclipidrilus frigidus n. sp.

Fig. 1. The interior of the 6th to 14 setigerous segments showing the sexual organs in situ. The female organs are colored red, the male blue.

ov. = ovary.

rs. = seminal receptacle (female).

ovd = oviduct.

efd = efferent duct.

t. = testes.

v.s = seminal vesicle of the efferent duct (male).

The testes which are overlying the sexual organs are represented as pellucid, which in reality they are not.

Fig. 2. The front part of the worm showing the vascular system. The pulsating vessels are colored red, the non pulsating blue.

D. v. = dorsal vessel.

V. v. = ventral vessel.

g. v. p. = primary gastric vessels.

g. v. s. = secondary gastric vessels.

p. v. = perigastric vessels.

The setigerous segments are numbered 1 to 14.

Fig. 3. Some of the last segments of the body, showing the posterior part of the vascular system.

D. v. = dorsal vessel.

V. v. = ventral vessel.

p. v. f. = free perigastric vessel.

Fig. 4. Schematic view of the ventral side of the 8th to 11th setigerous segments showing the exterior orifices of the generative and segmental organs.

r. s. = orifice of seminal receptacle.

efd = " " efferent duct or sexual porus.

ovd = orifice of oviduct.

s. o. = " " segmental organ.

sp. = spines.

Fig. 5. Two spines highly magnified.

Fig. 6. the oviduct, dito.

Fig. 7. a. b. c. different kinds or aspects of spermatozoa-cysts.

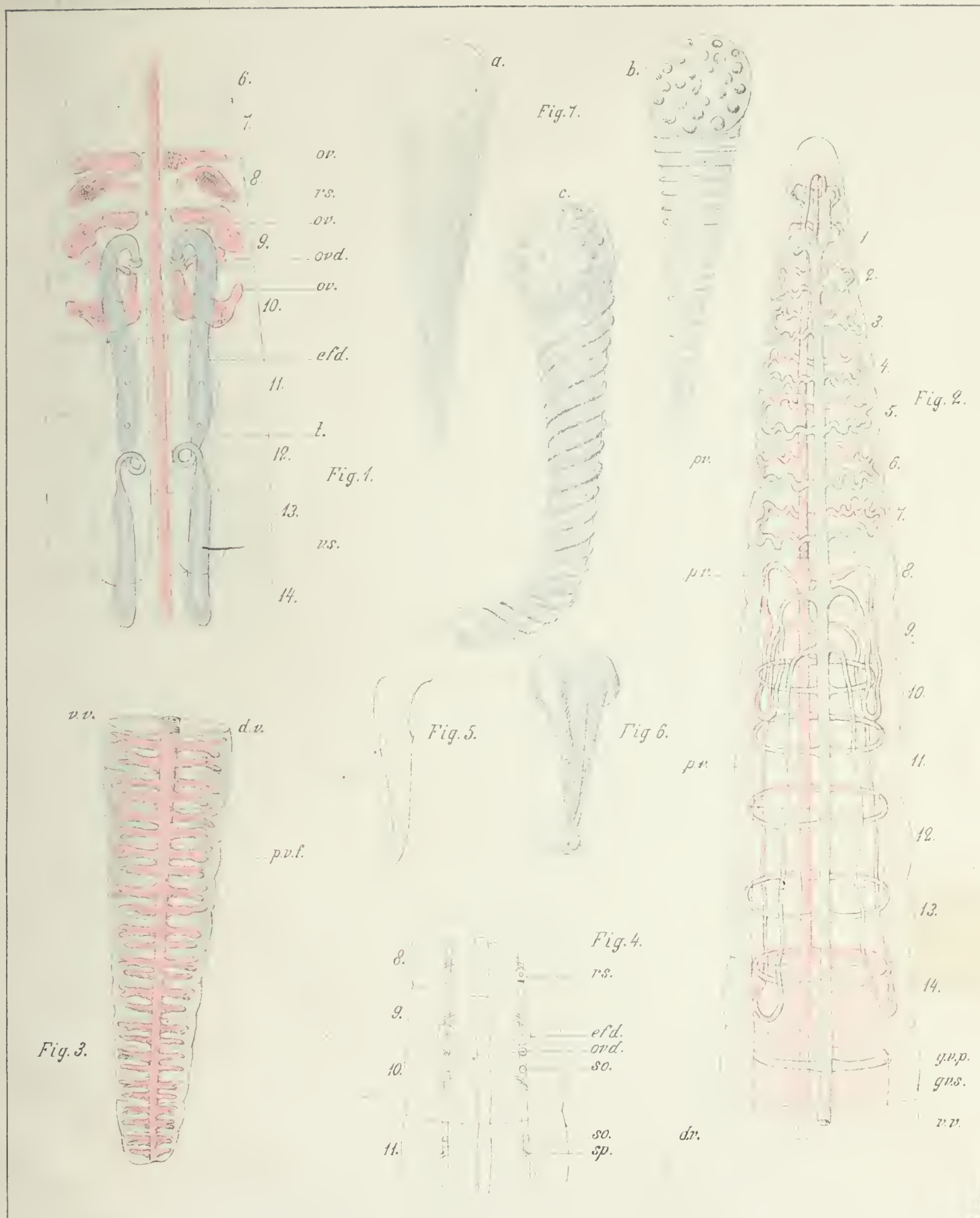
Pl. II.

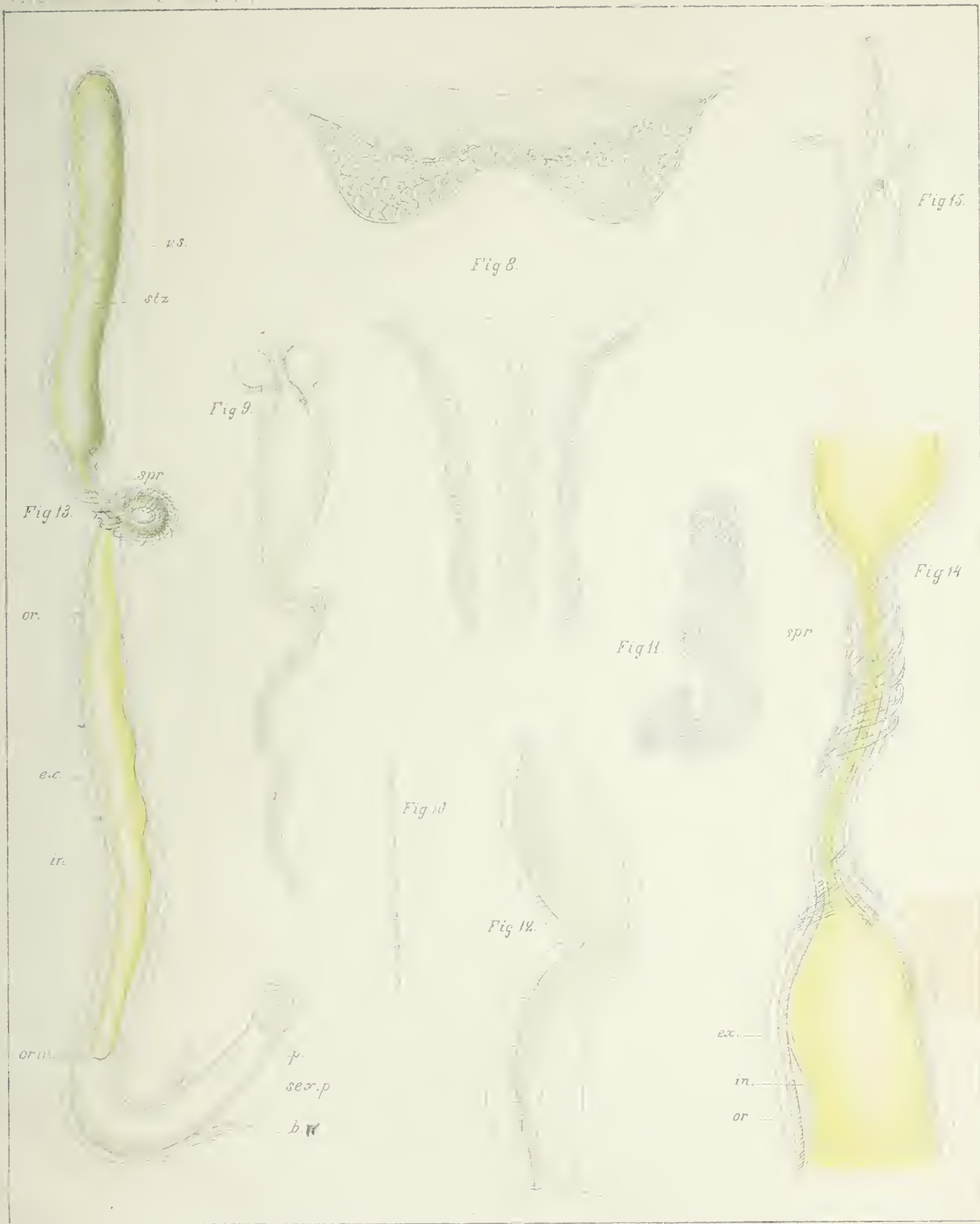
Eclipidrillus frigidus n. sp.

- Fig. 8. The cephalic ganglion, and the anterior part of the ventral nerve cord.
 Fig. 9. The interior extremity of the segmental organs.
 Fig. 10. *Eclipidrillus frigidus*, nat. size.
 Fig. 11. One of the ovaries.
 Fig. 12. One of the seminal receptacles.
 Fig. 13. The efferent duct, highly mgfd.
 p. = penis.
 b. w. = body wall.
 ex. = exterior duct.
 in. = interior duct.
 or. in = orifice of interior duct.
 or. = orifice of exterior duct.
 spr. = spiral muscles.
 stz. = spermatozoa.
 v. s. = seminal vesicle.
 sex. p. = sexual porus.
 Fig. 14. The middle part of the same, only more magnified, to show the different layers, and the orifices of the exterior duct. Letters as above.
 Fig. 15. The exterior extremity of the efferent-duct, showing the penis proper.

Fresno, California, July 13th 1880.







Eclipidrilus frigidus, n. sp.

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